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Glossary of terms for use in LANDMARK

(deliverable D 1.1.)

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Preface

Participants of LANDMARK (EU Horizon 2020, project 635201) not only come from different countries, speaking different languages, but also reflect quite different scientific disciplines and professional arenas. While definitely a merit in its own right, these differences can also create confusion as far as the terminology is concerned. This glossary intends to establish common ground for the LANDMARK project. It was decided to kick-off the work on a glossary at an early stage of the project in order to develop that shared understanding as quickly as possible. However, it implies also that the glossary will be reshaped during the project. We therefore welcome all your comments and proposals for amendments and clarifications.

The Editors

Contents

1. Functional land use

Agroforestry	A type of land use that combines production on the same plot of land, from annual agricultural activities (such as crops and pasture) and from delayed long-term production by trees (for example timber and services). This is obtained either by planting trees on agricultural land or by cropping (for example after thinning) on forested land. Plots that combine arable intercrops with forestry trees are silvoarable plots, while wooded plots with pasture under the tree canopy are known as silvopastoral plots.
Attribute	A characteristic of the soil system contributing to the generation of a soil function. One attribute can contribute to more soil functions. Attributes can be quantified with indicators A concrete aspect of the system (in the case of LANDMARK: plausibly linked to a soil function) for which indicators can be envisaged. Soil pH, NO3-transport to groundwater, NH3-release, water infiltration rate, soil respiration, crop management, pedo-climatic zone, and land use are examples of attributes which are relevant for LANDMARK's soil functions. Attributes can be quantified by applying a suitable indicator.
Biodiversity and habitat	The multitude of soil organisms and processes, interacting in an ecosystem, making up a significant part of the soil's natural capital, providing society with a wide range of cultural services and unknown services.
Carbon sequestration	The capacity of a soil store carbon in a non-labile form with the aim to reduce the CO2 concentration
Climate regulation	The capacity of a soil to reduce the negative impact of increased greenhouse gas (i.e., CO2, CH4, and N2O) emissions on climate, among which its capacity to store carbon.
CO_2 equivalent	A metric measure used to compare the emissions from various greenhouse gases on the basis of their global-warming potential (GWP), by converting amounts of other gases to the equivalent amount of carbon dioxide with the same global warming potential. Carbon dioxide equivalents are commonly expressed

	as million metric tonnes of carbon dioxide equivalents, abbreviated as Mt CO_2e. The carbon dioxide equivalent for a gas is derived by multiplying the tonnes of the gas by the associated GWP: Mt CO_2e = (million metric tonnes of a gas) * (GWP of the gas). For example, the GWP for methane is 21 (minus 1 unit if pertaining to biogenic CH_4 as that would alternatively have become 1 CO_2) and for nitrous oxide 310. This means that emissions of 1 million metric tonnes of methane and nitrous oxide respectively is equivalent to emissions of 21 and 310 million metric tonnes of carbon dioxide.
Ecosystem service	Benefits (provisioning, regulating, supporting and cultural services) that people obtain from ecosystems, including attributes and processes through which natural and managed ecosystems can sustain ecosystem functions (http://www.millenniumassessment.org/en/index.html).
Edaphon	The community of soil organisms (microbes, fungi, nematodes, worms, insects, protozoa, etc.)
Functional land management	A conceptual framework for optimising the supply of soil-based ecosystem services, grouped together in five overarching soil functions, to the demands at a range of spatial scales, with a view to simultaneously meeting agronomic and environmental policy objectives (Schulte et al., 2014; O'Sullivan et al., 2015).
Indicator	An instrument (measurement, dataset, model, expert elicitation system) for quantifying an attribute, providing quantitative information of the system. For instance, the protocol for soil sampling and pH (KCL) measurement is an indicator for the 'soil pH', and the extraction, counting, identification of nematodes and calculation of the maturity index is an indicator for the 'nematode community in the soil system'. Note that this definition differs from the daily practice where, for example, the pH or the nematode community as such, and not the protocol, is seen as the indicator.
Land cover	The observed (bio)physical cover of the Earth's surface. The main classes in the LUCAS land cover nomenclature are as follows (http://ec.europa.eu/eurostat/ramon/other_documents/lucas/index.htm):

A00	Artificial land

B00	Cropland
C00	Woodland
D00	Shrubland
E00	Grassland
F00	Bareland
G00	Water
H00	Wetland

Land use

The socio-economic purpose of the land. The main classes in the LUCAS land use nomenclature (http://ec.europa.eu/eurostat/ramon/other_documents/lucas/index.htm) are as follows:

U110	Agriculture
U120	Forestry
U130	Fishing
U140	Mining and quarrying
U150	Hunting
U210	Energy production
U220	Industry and manufacturing
U310	Transport, communication networks, storage and protective works
U320	Water and waste treatment
U330	Construction
U340	Commerce, finance and business
U350	Community services
U360	Recreational, leisure and sport
U370	Residential
U400	Unused

Note: Within the framework of the LANDMARK project only Agriculture (U110) and Forestry (U120) will be considered.

Natural capital

Refers to both the living (e.g. fish stocks, forests) and non-living (e.g. minerals, energy resources) aspects of nature which produce value to people, both directly and indirectly. It is this capital that underpins all other capital in our economy and society. Natural capital can often be confused with ecosystem services. However, whilst similar concepts, they are fundamentally different. Natural capital refers to the actual stock (living and non-living parts) that provides value whereas ecosystem services refer to the flow of benefits that this stock provides. Essentially, natural capital is about nature's assets, whilst ecosystem services relate to the goods and services derived from those assets (http://www.britishecologicalsociety.org/?s=natural+capital).

Nestedness

This is a specific feature of LANDMARK deliverables from WP3 (i.e. the harmonization of proxy indicator systems among different spatial and temporal scales). One of the means to

	realize this is to collect indicators, and/or proxies, which have overlap for use at different spatial/temporal scales. For instance, land use as proxy should be useful for the EU/national and at the regional scale, while crop rotation should be useful for the regional and farm scale.
Nutrient cycling	The capacity of a soil to receive nutrients in the form of by-products, to provide nutrients from intrinsic resources or to support the acquisition of nutrients from air or water, and to effectively carry over these nutrients into harvested crops.
Proxy	A measure linking information from an indicator (see: indicator) to a non-concrete (immaterial) end-point ('soil function' in the case of LANDMARK). However, a proxy only contributes to a soil function and cannot be held responsible to full quantification (see proxy indicator system).
Proxy indicator system	A combined set of indicators, weighting factors and algorithms for quantification of a soil function based on the quantification of an agreed set of attributes. A proxy indicator system aims at the assemblage of a wide-ranging set of information from indicators (in fact: all required proxies) and provides a quantification protocol of a specific soil function, being as such a compromise between ease of measurement / data availability, whilst providing sufficient, if minimal, information on the attribute (set). Different proxy indicator systems may arise for one soil function, depending on requirements for a) specific spatial/temporal scale, b) agricultural objective, soil texture and climate conditions, and c) the required performance (reduction of uncertainty) and available budgets to harness the proxy indicator system with reliable data and models. It is the objective of LANDMARK to produce proxy indicator systems which are at least partially overlapping (see 'nestedness').
Resistance	The ability of an ecosystem to withstand a stress or perturbation without adverse changes to its structure or function, thereby maintaining an equilibrium state.
Resilience	The ability of an ecosystem to maintain diversity, integrity and ecological processes following disturbance (i.e. by returning to its initial state after stress).

S x E x M	Expression used to indicate that there are intricate interactions between soil properties i.e. diagnostic features (intrinsic and dynamic ones), environment (climate, weather, slope, etc.) and management (the analogue from crop production is G (genotype) x E x M), acknowledging that soil functions are never uniquely determined by just one of these three factors.
Soil functions	Soil based ecosystem services: an overarching concept referring to one (out of five, following Schulte et al., 2014) elemental aspect of the soil system that contributes to the generation of goods and services. The contemporary principal soil functions pertaining to agricultural land use (U110) and forestry (U120) include: (1) primary productivity, (2) water purification and regulation, (3) carbon sequestration and other aspects of climate regulation, (4) provision of a habitat for functional and intrinsic biodiversity and (5) nutrient cycling and provision, with: $SFi,j = F$ *(soil features, environmental variables, management options)* *where* SFi,j *is soil function i for agricultural objective j.*
Soil productivity	The capacity of a soil to produce plant biomass for human use, providing food, feed, fibre and fuel within natural or managed ecosystem boundaries
Soil quality	The degree to which a soil can perform its soil functions. A soil with 'high soil quality' can deliver the desired functions to meet demands, whereas a soil with 'low soil quality' delivers functions at sub-optimal rates.
Water purification	The capacity of a soil to remove harmful compounds from the water that it holds.
Water regulation	The capacity of a soil to receive, store and conduct water for subsequent use and the reduction of consequences of prolonged droughts and risks of flooding and erosion.

2. Threats to soil quality

Acidification	The process in which the concentration of hydrogen ions in the soil gradually increases, caused by removal of (slightly alkaline) crop produce, leaching and the use of acidifying N fertilizer types, accelerated or insufficiently compensated by the natural constituents of a soil among which the parent material.
Cracking	Formation of vertical fissures in a soil which promote the downward preferential flow of water with or without particulate matter or salts.
Desertification	The process in which relatively dry land becomes increasingly arid, typically losing its bodies of water as well as vegetation and wildlife either directly via climate change or indirectly via soil degradation resulting from poor management.
Erosion	The wearing away of the land surface by water, wind, ice, gravity or other natural or anthropogenic agents that abrade, detach and remove soil particles or rock material from one point on the earth's surface, for deposition elsewhere, including gravitational creep and so-called tillage erosion.
Exhaustion	The gradual depletion of reserves of nutrients and organic matter in soils.
Infestation	Accumulation of agents able to promote biological stress and subsequent loss of yield such as nematodes, weeds, microorganisms, mice, etcetera, favoured by, for instance, a too narrow crop rotation.
Land take	Increase of settlement areas over time. This process includes the development of scattered settlements in rural areas, the expansion of urban areas around an urban nucleus (including urban sprawl), and the conversion of land within an urban area (densification).

Organic matter loss	Decline of organic matter content in one or more soil layers when the annual loss of organic matter (e.g. due to oxidation or erosion) is insufficiently compensated for by the annual gain of organic matter, resulting from crop residues, composts and manures.
Salinization	Accumulation of soluble salts (more soluble than gypsum) in the upper soil layers (saline soil = soil containing enough soluble salts to negatively affect most crop plants, commonly 4000 µS m-1).
Slaking	Sealing of the (upper few cm) soil by the destruction of soil aggregates after wetting, causing a fine crust to occur, which reduces permeability of the soil and hamper seedling emergence.
Sodification	Increase in the amount of exchangeable Na of a soil (sodic soil = soil containing enough Na to negatively affect most crop plants by changing the physical soil properties).
Soil compaction	Changing the nature of the soil such that there is a decrease in the volume of voids between soil particles or aggregates; it is manifested as an increase in bulk density and a severely compacted soil can become significantly less permeable and less aerated. Manmade compaction is caused by poaching (trampling of animal hooves repeatedly) or by the passage of heavy machinery. Other typical examples are “plough pans” (plough sole or traffic pan) which can be formed due to tillage and which can negatively affect root development and drainage.
Soil contamination	Accumulation of nutrients, metals or organic compounds leading to a reduction of the capacity of soils to deliver soil functions. Contamination may have a direct toxic effect on the plants, animals or humans living in, on, or from that soil, or have an indirect toxic effect due to accumulation in the whole trophic chain.
Soil sealing	The process of covering of a soil by buildings, or types of artificial material which may be very slowly permeable to water (e.g. asphalt or concrete). Soil sealing can cause rapid overland flow after precipitation where water cannot soak away leading to

potential flooding. A soil is unable to function effectively when sealed.

3. Farms

3.1 Typology

Agri-environmental zone (AEZ)	A spatially homogeneous area with distinctive characteristics in terms of the present climate, soil type and slope (http://www.fao.org/nr/land/databasesinformation-systems/aez-agro-ecological-zoning-system/en/).
Agricultural Area, AA or Utilized Agricultural Area, UAA	The extent of land used for farming, including arable land, permanent grassland, permanent crops and other agricultural land such as kitchen gardens, but excluding unused agricultural land, woodland and land occupied by buildings, farmyards, tracks, ponds, scrub land, etc.
Conventional farming	A farming method that includes the use of synthetic chemical fertilizers, pesticides and herbicides and genetically modified organisms, allowing this type of farms to be less depending on cultural (crop rotation, inclusion of crops fixing atmospheric N), biological, and mechanical practices that foster cycling of resources, promote ecological balance, and conserve biodiversity.
Extensification	The process of decreasing the use of capital and inputs (e.g. fertilizers, pesticides, machinery, energy) relative to land area. Due to a decrease in inputs per land area the pressure on the environment may be decreased. A decrease in pesticides used, for instance, is likely to decrease the risk of pesticide run-off in surface and groundwater (‘loss per unit area’). However, the actual effect of a decrease in the use of inputs on the environment does not only depend on the amount of inputs used but also on how they are applied and the extent to which

	decreased inputs lead to lower production ('loss per unit produce'). Therefore, extensification does not necessarily lead to an environmentally more benign situation.
Farm type (FT)	The flag characterizing which activity generates the income for a farm and which crops are predominantly grown/animals are kept for that (in the case of Catch-C leaving out features such as intensity and size); consult Table 1.
Farm Type Zone (FTZ)	A spatially homogeneous area with distinctive characteristics in terms of the present climate, soil texture, slope and farm type, thus combining AEZs and FTs.
Farm typology	Characterisation of a farm in terms of its size, specialisation and intensity.

Farm size (source: www.seamlessassociation.org)

Name	
Small scale	< 16 ESU*
Medium scale	=> 16 and < 40 ESU
Large scale	=> 40 ESU

*ESU: European Size Unit = 1200 euros standard gross margin (http://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Standard_gross_margin_(SGM))

Farm intensity (source: www.seamlessassociation.org)

Name	
Low intensity	output < 500 euros/ha
Medium intensity	output => 500 and < 3000 euros/ha
High intensity	=> 3000 euros/ha

Table 1. Farm type assignment based on main source of income (Catch-C, Hijbeek et al., 2013)

Type name	Type code	Specification
Arable systems (specialised field crops and mixed cropping)	1+6	- >1/3 of standard gross margin from general cropping (arable farming) - Or > 1/3 but < 2/3 of standard gross margin from horticulture - Or > 1/3 but < 2/3 of standard gross margin from permanent crops Combined with < 1/3 of standard gross margin from meadows and
Permanent crops	3	> 2/3 of standard gross margin from permanent crops
Horticulture	2	> 2/3 of standard gross margin from horticultural crops
Dairy cattle	4.1	> 2/3 of standard gross margin from dairy cattle
Beef and mixed cattle	4.2+4.3	> 2/3 of standard gross margin from cattle and < 2/3 from dairy cattle
Sheep, goats and mixed grazing livestock	4.4	> 2/3 of standard gross margin from grazing livestock and < 2/3 from cattle
Pigs	5.1	>2/3 of standard gross margin from pigs
Poultry and mixed pigs/poultry	5.2	> 2/3 of standard gross margin from pigs and poultry and < 2/3 from pigs
Mixed livestock	7	> 1/3 and < 2/3 of standard gross margin from pigs and poultry and/or >1/3 and < 2/3 from cattle
Mixed farm	8	All other farms

Farm type assignment based on dominant crop or animal type (Catch-C, Hijbeek et al., 2013)

Code	Crop/Animal	Criterion
1	Land independent	UAA* = 0 or LU**/ha> 5
2	Horticulture	Not 1 and > 50% of UAA in horticultural crops
3	Permanent crops, excl. grassland	Not 1 and 2 and > 50% of UAA in permanent crops
4	Temporary grassland	Not 1,2 or 3 and > 50% of UAA in grassland and > 50% of grassland in temporary grass
5	Permanent grassland	Not 1,2,3 and > 50% of UAA in grassland and < 50% of grassland in temporary grass
6	Fallow land	Not 1,2,3,4 or 5 and > 50% of UAA in fallow
7	Cereals	Not 1,2,3,4,5 or 6 and > 50% of UAA in cereals
8	Specialised crops	Not 1,2,3,4,5,6,7 and > 25% in specialised crops***
9	Mixed crops (others)	Not 1,2,3,4,5,6,7 or 8

**see UAA; **see LU; ***grain maize, potatoes, sugar beet, hops, soya, tobacco, medicinal plants, sugar cane, cotton, fibre flax, hemp, mushrooms, vegetables in open, flowers in open, grass seeds, other seeds.*

Intensification

The process of increasing the use of inputs (labour, information, energy, fertilizers, pesticides, machinery) relative to land area, to increase agricultural production per unit area. Intensification may increase the pressure on the environment, if it is comprised of an indiscriminate increase of the use of inputs without an associated increase in managerial input. A higher use of fertilizers and pesticides, for instance, may increase the risk of nutrient and pesticide run-off into surface and groundwater ('loss per unit area'). However, the actual effect of the use of inputs on the environment does not only depend on the amount of inputs used but also on how they are applied and the extent to which they contribute to production increases ('loss per unit produce'). Therefore, intensification does not necessarily need to lead to environmental degradation.

Organic farming

Agricultural production which typically places a higher emphasis on environmental and wildlife protection and, with regard to livestock production, on measures that are supposedly animal welfare friendly. Organic production aims at more holistic production management systems for crops and livestock,

	emphasizing on-farm management practices over off-farm inputs. This involves avoiding, or largely reducing, the use of synthetic chemicals such as inorganic fertilizers, pesticides, medicinal products, replacing them, wherever possible, with cultural, biological and mechanical methods. Organic producers explicitly aim to develop an allegedly healthier, fertile soil by growing and rotating a mixture of crops and using leguminous crops to fix nitrogen from the atmosphere. The production of genetically-modified (GM) crops and their use in animal feed is banned. In the context of European Union (EU) statistics, farming is considered to be organic if it complies with Regulation 834/2007 of 28 June 2007 on organic production and labelling of organic products. The detailed rules for the implementation of this Regulation are laid down in Regulation 889/2008.
Sustainable intensification	Policies and practices directed at increasing the productivity ('yield per unit area') without increasing the environmental impact ('impact per unit area and produce') (Garnett et al., 2013).

3.2 Management practices

3.2.1 Tillage

Conservation agriculture (CA)	A farming method including minimum soil disturbance (no tillage, minimum tillage, reduced tillage, strip tillage, direct drill), crop rotation, and permanent soil cover (http://www.fao.org/ag/ca/).
Conventional Tillage	Full width tillage that disturbs the entire soil surface which is generally performed prior to planting. It usually involves a primary operation by depth ploughing or chiselling (commonly to 20-30 cm depth), followed by secondary operation such as rotavating or harrowing that pulverizes, flattens, and firms the surface.
Direct sowing, direct drilling	Planting crops in a non-inverted soil without seedbed preparation (i.e. under no-tillage).
Ground cover (GC)	The most widely used agronomic practice in CA, whereby the soil surface between rows of annual or perennial crops remains protected against erosion. With this technique, at least 30% of the soil is protected either by sown cover crops, spontaneous vegetation or inert covers, such as pruning residues or tree

	leaves. For the establishment of sown cover crops and the spread of inert covers, farmers must use methods in coherence with CA principle of minimum soil disturbance.
Minimum tillage	A tillage system that limits tillage operations to those essential to crop production and prevention of soil damage, generally leaving about 30% crop residues on the surface, often executed with specific machines (e.g. harrow, cultivator with rigid tines or a rotavator), only once a year.
Mulch	Organic residues left on top of the soil or in the first few cm of soil.
Mulching	Leaving organic residues (or plastic sheet) on top of the soil or in the first few cm of soil.
Plastic mulch	Plastic sheet covering the soil surface to increase the temperature, reduce evaporation or suppress weeds.
Reduced tillage	A tillage without inversion at a reduced depth (about 30% crop residues remaining on the surface), with specific machines (often with grubber/cultivator), more than once a year.
Strip Tillage	The process in which only a narrow strip of land needed for the crop row is tilled.
Tillage	The mechanical cultivation of a soil profile for any purpose. Tillage can be performed to accomplish a number of tasks including: breaking compactions, incorporation of crop residues, manures, fertilizers or weeds, seedbed preparation, weed control.
Zero tillage, No tillage (NT)	An agronomic practice in CA for annual crops, and is defined as a way to farm without disturbing the soil through tillage. NT must leave at least 30% of area covered by plant residues right after crop establishment, and crops are sown using machinery which is able to place seeds through plant residues from previous crops. The agronomic practice that best characterizes CA for annual crops is NT, which has the highest degree of soil conservation in annual crops, since the mechanical tillage of the ground is completely suppressed. Also, in arid climates it enhance water retention in soils through decreasing evaporation

losses from the soil surface which is usually enhanced by tillage involving soil invert.

3.2.2 Fertilizers and manures

Apparent recovery	Fraction of an applied nutrient (kg per kg) recovered in above ground or harvested crop parts in addition to the amount of that nutrient taken up in an unfertilized control.
Apparent efficiency	Yield increase of a crop per unit of nutrient applied (kg per kg) in addition to the yield of an unfertilized control.
Ca, calcium	CaO Ca x 1.39 = CaO
Compost	The material used to supply organic matter or plant nutrients to a soil, resulting from composting.
Composting	Aerobic microbial decomposition and transformation of organic materials. It is usually achieved by regular turning and aeration of a stored organic product in piles with a geometry that can favour aeration. With this transformation, the chemical composition, particularly the C to N ratio comes closer to values needed for the net release of N once the product is land-applied. Concomitantly, the product may become less bulky due to the loss of water and also more manageable due to homogenisation. Additional benefits of composting involve the decrease in the initial phyto-toxicity of organic materials used, reduction in weed and pest infestation, and potential biocontrol effects.
Digestate	Liquid or solid residues produced by fermentation of biomass (anaerobic digestion) in a biogas plant.
Fertilizer	Substance used in agriculture to provide crops with vital nutrients to grow (such as Nitrogen (N), Phosphorus (P), Potassium (K) and lime).
Fertilizer replacement value	The extent to which a nutrient (N, P) in a manure or in a compost is as plant-available as that nutrient in a common mineral equivalent applied according to good agricultural practices,

usually expressed as kg per 100 kg applied = fertilizer equivalency = ratio of apparent recoveries* (or of apparent efficiencies**) of a nutrient (often N) from manure and from a commonly used mineral fertilizer equivalent.

Harvest index — Fraction of fresh matter, dry matter, N, P or K allocated to the harvested crop fraction(s).

Inorganic fertilizers — Mineral, synthetic, industrial, artificial or manufactured fertilizers.

K, potash — K_2O K x 1,20 = K_2O

Livestock Unit (L(S)U) — A reference unit which facilitates the aggregation of livestock from various species and age as per convention, via the use of specific coefficients established initially on the basis of the nutritional or feed requirement of each type of animal (see table below for an overview of the most commonly used coefficients).
The reference unit used for the calculation of livestock units (=1 LSU) is the grazing equivalent of one adult dairy cow producing 3 000 kg of milk annually, without additional concentrated foodstuffs.
LU's as derived from the LUCAS land use nomenclature (http://ec.europa.eu/eurostat/ramon/other_documents/lucas/index.htm):

Bovine animals		
	Under 1 year old	0,400
	1 but less than 2 years old	0,700
	Male, 2 years old and over	1,000
	Heifers, 2 years old and over	0,800
	Dairy cows	1,000
	Other cows, 2 years old and over	0,800
Sheep and goats		0,100
Equidae		0,800
Pigs	Piglets having a live weight of under 20 kg	0,027
	Breeding sows weighing 50 kg and over	0,500
	Other pigs	0,300
Poultry	Broilers	0,007
	Laying hens	0,014
	Ostriches	0,350
	Other poultry	0,030
Rabbits, breeding females		0,020

Mg, magnesium — MgO Mg x 1.66 = MgO

Manure	Livestock excrements, as such or including bedding material.
N, nitrogen	NO_3 N x 4.43 = NO_3
N, nitrogen	NH_4 N x 1,29 = NH_4
Nutrient recovery	Fraction of plant-available nutrients from fertilizers and manures taken up by the crop in harvestable fraction(s) and above ground residues, usually excluding roots and stubbles.
Organic fertilizers	Livestock manures, digestates, green manures, compost, sewage sludge, (agro)industrial organic waste.
P, phosphorus	P_2O_5 P x 2.29 = P_2O_5
Residue	Any organic product generated during the production, processing or consumption of crops, ranging from roots, stubbles, straw and leaves, to industrial and urban 'wastes'.
Slurry	A liquid mixture of livestock urine and faeces, with or without some water and or bedding material.

3.2.3 Crops

Cash Crop	An agricultural crop grown to provide revenue from an off-farm source ('the market').
Catch crop	Non-harvested crop grown in between two main crop seasons, mainly intended to scavenge residual soil mineral N and thus potentially growing under N limitation.
Contour ploughing	Ploughing in a direction that follows the contour, maintaining the same elevation.
Contour strip cropping	Growing crops in strips that follow the contour line. Strips of grass or close-growing crops alternate with strips of clean-tilled crops or summer fallow.
Controlled traffic	Using the same traffic lanes for machinery used for different applications within one year and the same traffic lanes across years, usually supported by a sat-nav system, in order to reduce soil compaction.

Cover crop	Non-harvested crop grown in between two main crop seasons, mainly intended to protect the structural aspects of soil fertility and reduce erosion.
Crop rotation	The temporal alternation of different crop types (mown vs. lifted, monocots vs dicots, annual vs perennial) on a piece of farm land.
Cropping frequency	The period after which a crop type returns to a field in the course of years, commonly expressed as a percentage of the number of years needed for a full crop rotation cycle.
Effective rooting depth	The soil depth from which a fully grown plant can easily extract most of the water needed for transpiration. It can be limited by physical (e.g. cemented pan) or chemical (e.g. saline horizon) properties.
Evaporation	The rate of water loss from liquid to vapour (gaseous) state from an open water, wet soil or plant surface, usually expressed in mm day^{-1}.
Evapotranspiration	The process by which water passes from a liquid to a vapour (gaseous) state through transpiration from vegetation, and evaporation from soil and plant surfaces. The rate of evapotranspiration is usually expressed in mm day^{-1}; a distinction can be made between the potential evapotranspiration under unlimited availability of water and the actual evapotranspiration under limited availability.
Fallow	Cropland left idle in order to restore productivity through accumulation of moisture or organic matter. Summer fallow is common in regions of limited rainfall where cereal grains are grown. The soil is tilled for at least one growing season for weed control and decomposition of plant residue.
Green manure	Non-harvested crop grown in between two main crop seasons, intended to improve the soil fertility, generally not growing under N limitation due to the use of fertilizers and manures, or the ability to fix atmospheric N.
Growing season	The portion of the year when soil and air temperature allow biological activity; this period can be approximated by the number of frost-free days.

Intercrop	A crop grown amidst a main crop or in between the planting rows of that main crop and intended to be harvested or to be supportive to the harvest of the main crop.
Monoculture	The growing of a single arable crop species on a field year after year, for at least 10 years.
Nurse crop	Main crop under which an undersowing is established which accompanies the main crop during at least a part of its growing season.
Relay intercrop	Intercrop.
Root zone	The part of the soil that can be penetrated by plant roots.
Soil cover	The extent to which a soil is covered (in space and/or time) by a vegetation, including crops, or dead crop residues on the surface of the soil, directed at reducing soil erosion and the loss of particulate pollutants (i.e. those attached to soil) including nutrients, plant protection products and faecal microbes. Measures directed at increasing the soil cover may also increase soil organic matter.
Strip cropping	Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to wind and water erosion.
Transpiration	The process whereby plants lose water by evaporation of liquid water at the surface of the stomatal cells, the water vapour diffusing out through the leaf via the stomata openings.
Under-sowing	A crop grown under a nurse crop and intended to become either a non-harvested crop grown in between two main crop seasons or become a main crop itself in a next season.

3.2.4 Crop protection

Biological control	The use of biological agents (intact organisms, components derived from organisms) to destroy or deter pests and diseases or to promote natural enemies.
Mechanical weeding	The use of machines to bury, cut or uproot the weeds.
Pesticides	Synthetic biocide directed at destroying insects, nematodes, molluscs, mammals, plants, fungi or bacteria.

3.2.5 Water management

Aquifer	Underground reserve of freshwater usually contained in a discrete layer of water-permeable rock or other material (such as gravel, sand etc.) from which water can be extracted using a well or other appropriate extraction technology.
Available soil water	Total amount of water in the root zone that is available for evapotranspiration, usually expressed in mm.
Bearing capacity	The weight a soil can withstand before severe damage occurs to the structure of the soil. Bearing capacity varies throughout the year, based upon the moisture content of the soil. For instance a very heavy tractor that causes no damage on dry soils may cause a lot of damage to the soil structure of wetted soils.
Drainage (artificial)	Man-made systems of furrows, ditches, pipes to improve the evacuation of excess water from the soil.
Drainage (natural)	Refers to the capacity of unaltered soils to drain water through percolation, as opposed to artificial drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets.
Drip irrigation	Application of water under low pressure through a piped network in a pre-determined pattern, applied as a small discharge close to each plant and adjustable by irrigation nozzles or droppers. Usually called “high frequency irrigation” since irrigation rates are usually very small and intended to compensate crop evapotranspiration during one or a few days.
Field capacity	The moisture condition where a soil contains the maximum amount of water that it can hold against gravity, and where further wetting will result in drainage. Following saturation, soils typically return to field capacity, when the rate of downward movement of water has substantially decreased, usually 1-3 days after rain or irrigation after the gravitational, or free, water has drained away.

	It is typically expressed as a mass or volume fraction of soil water or as a soil moisture deficit (SMD) of zero.
Groundwater	Freshwater found beneath the earth's surface that fills the cavities of the earth's crust (pores, crevices, etc. in soil, sand and rock) contiguously, – and that supplies wells and springs, excluding the water in the vadose (unsaturated) zone. The definition applies to all permanent and temporary water deposits, formed both artificially and naturally, of sufficient quality for at least seasonal use. Groundwater supplies are replenished, or recharged, by rain and melting snow, depending on climate conditions. They can usually be recovered from, or via, an underground formation.
Infiltration capacity	The maximum rate at which water can infiltrate into a soil under a given set of conditions.
Infiltration rate	The speed at which water can pass into the soil, being typically lower in wet clay than in dry sand (unless sand has become hydrophobic).
Infiltration	The movement of water passing the soil surface into the soil (as contrasted with percolation, which is movement of water through soil layers moving down to the aquifers, or out to rivers).
Irrigation	Application of water to soils to assist in production of crops.
Permeability	The quality of the soil that enables water to move downward through the profile. Permeability is measured as the distance per unit time that water moves downward through the saturated soil. Terms describing permeability are:

Very slow:	0.15 cm/hr
Slow:	0.15-0.5 cm/hr
Moderately slow	0.5-1.5 cm/hr
Moderate	1.5-5 cm/hr
Moderately rapid	5.00-15.00 cm/hr
Rapid	15-50 cm/hr
Very rapid	>50 cm/hr

Preferential flow	Water flow through macro-pores (e.g., cracks, root channels) in the unsaturated/ vadose zone
Saturated zone	Subsurface area below unsaturated/ vadose zone that is permanently water-saturated.
Sprinkler irrigation	Application of water to the field by a sprinkler system which mimics a high intensity rainfall, can be mobile of fixed.
Surface irrigation	Application of water to the field that flows over the land surface or in narrow channels (e.g.furrow or basin sprinkler).
Surface water	Water bodies flowing over or resting on the surface of a land mass, natural waterway (rivers, streams, brooks and lakes) or artificial waterway, including irrigation, industrial and navigation canals, drainage systems and artificial reservoirs.
Trafficability	The capacity of soil to carry machinery without significant damage to the soil or the vegetation growing on it.
Vadose zone	The aerated region of soil above the groundwater table. The unsaturated zone is characterized by a downward movement of leachate.
Water deficit	Amount of water (mm) needed to return moisture conditions of a soil back to field capacity.
Water holding capacity	The capacity of soils to hold water that is available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as mm of water per m of soil.
Water table	The upper surface of groundwater or that level in the ground where the water is at atmospheric pressure. Different horizons can be recognized, such as the highest and lowest average height of the groundwater level in summer or winter.
Wilting point	Soil moisture content where the rate of absorption of water by plant roots is too slow to maintain plant turgidity and permanent wilting occurs. The average moisture tension at the outside surface of the moisture film around soil particles when permanent wilting occurs is 1500 kPa.

4. Soils

4.1 General

A horizon	The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, any ploughed or disturbed surface layer.
B horizon	Mineral horizon below an O, A, or E horizon. The B horizon show evidences of soil forming processes which distinguish it from the parent material of soil (underlying C horizon). The distinctive characteristics can be: (1) accumulation (iluviation) of clay, sesquioxides, humus, or a combination of these; (2) granular, prismatic, or blocky structure; (3) redder or browner colours than those in the A horizon; (4) evidences of accumulation of secondary gypsum or carbonates; or (5) a combination of these.
Bedrock	The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.
C horizon	Mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.
Diagnostic Horizon	Horizontal soil layers characterized by a combination of attributes that reflect widespread, common results of the processes of soil formation (Bridges, 1997) or indicates specific conditions of soil formation.(WRB, 2006).
E horizon	Albic horizon, which is an eluvial horizon with evidences of losing soil components; it is usually a light-coloured subsurface horizon from which clay and free iron and aluminium have been removed to the extent that the colour of the horizon is

	determined by the colour of the sand and silt particles rather than by coatings on these particles.
Horizon	One of the layers that form in the soil profile as a result of soil-forming processes. A horizon can appear as a defined visible layer.
O horizon	A surface horizon, or a subsurface horizon occurring at any depth if it has been buried, that consists of poorly aerated organic material. It is usually undecomposed or partially decomposed organic matter (litter such as leaves, needles, twigs, moss, and lichens) (WRB, 2006). Often referred as the histic horizon (from Greek *histos*, tissue).
Parent material	The solid or unconsolidated mineral material in or on which soil forms.
Pedon	The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 1 to 10 m^2, depending on the variability of the soil.
Profile	A column of soil extending through all its horizons and into the parent material and large enough to be used to characterise the soil condition at a particular place.
R horizon	Hard, consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon but can be directly below an A or a B horizon.
Soil depth	Depth of soil profile from the top to parent material or bedrock or to the layer below root penetration is not (or no longer) possible. It differs significantly for different soil types. It is one of basic criterions used in soil classification. Soils can be very shallow (less than 25 cm), shallow (25 cm-50 cm), moderately deep (50 cm-90 cm), deep (90cm-150 cm) and very deep (more than 150 cm).
Soil	A combination of four constituents: mineral material (sand, silt, clay and rock particles), organic material, air and water, forming a natural, three-dimensional body at the earth's surface. It is capable of supporting plant growth and has properties resulting

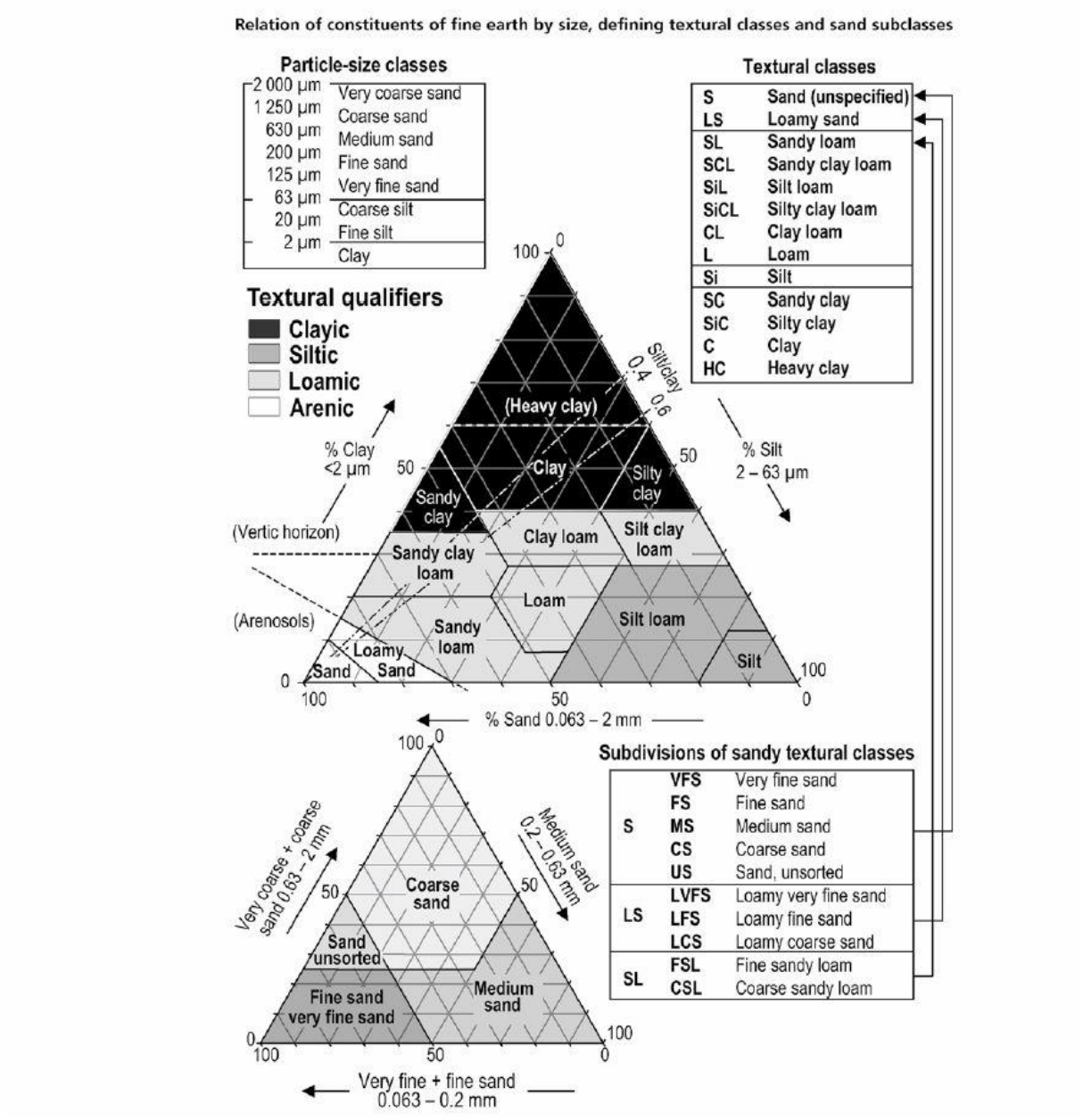
	from the integrated effect of climate and living matter acting on parent material, as conditioned by relief over periods of time.
Soil fertility	The ability of the soil to supply essential plant nutrients and soil water in adequate amounts and proportions for plant growth and reproduction in the absence of toxic substances which may inhibit plant growth.
Solum	Topsoil and subsoil layers that have undergone the same soil forming conditions. The base of the solum (plural, sola) is the relatively unweathered parent material. Solum and soils are not synonymous. Some soils include layers that are not affected by soil formation.
Subsoil	Technically, soil horizons below plough depth; usually B horizons.
Topsoil	The surface soil horizon (A) which is modified when cultivated, and designated Ap.

4.2 Plot and field scale

Aggregates	Soil aggregates are soil peds of a range of sizes (microaggregates 53-250µm and macroaggregates >250µm (usually taken as 250-2000µm)); Definitions and size classes can be found in Six et al. (2004).
Aggregation	Process whereby primary soil particles (sand, silt, clay) are bound together, usually by natural forces and substances derived from root exudates and microbial activity. Soil aggregates are arranged to form soil peds, units of soil structure, classified by shape, size or grade; Definitions and size classes can be found in Six et al. (2004).
Base saturation	The degree to which a soil having cation-exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation-exchange capacity.
Bulk density	The dry mass of soil per unit bulk volume of soil, expressed as g/cm^3, usually given on an oven-dry (110° C) basis.

Cation-exchange capacity, CEC	The total amount of exchangeable cations that can be held by the soil, expressed in terms of cmol of charge per kg of soil at neutrality (pH 7.0) or at some other stated pH value.
Clay	Soil particles less than 0.002 mm in diameter OR a soil textural class with 40% or more clay, less than 45% sand, and less than 40% silt.
Electrical conductivity (EC)	Measure of a material's ability to accommodate the transport of an electric charge and used as a measure of the salinity of the soil, and to estimate practical consequences for crops. EC of a soil suspension at a given soil to water ratio (usually 1:5 or saturated extract as a proxy to soil solution), expressed as Siemen per m.
Humus	The well decomposed, amorphous, stable fraction of the organic matter in mineral soils with a low specific weight and high surface area; usually composed of many organic compounds of high molecular weight and dark colour.
Organic matter	Plant and animal residue in the soil in various stages of decomposition.
Ped	An individual natural soil aggregate, in contrast to a clod caused by disturbance, or a concretion caused by cementation. Described as a range of shapes: platy (laminated), prismatic (vertical axis of aggregates longer than horizontal), columnar (prisms with rounded tops), blocky (angular or subangular) and granular.
pH	Measure of acidity, measured from 1 (acid) through 7 (neutral) to 14 (alkaline) expressed on a logarithmic scale. Most soils have a pH 3 to 9.
Pores	The space in-between particles or aggregates of soil that can become filled with air or water.
Porosity	Volume of water and air that can be held in a soil; ratio of the volume of voids to the total volume of the soil.
Sand	Soil particles being 0.06 (0.05[1]) -2.0 mm in diameter OR a soil textural class with 65% or more sand and less than 8% clay.

Silt	Soil particles being 0.002-0.06 (0.05[1]) mm.
Specific Heat Capacity (SHC)	The amount of heat which is required in order to increase its temperature. Measured in 'joules per kilogram per kelvin degree', or J/kg/^{o}K , it is specifically the amount of heat energy in joules needed to increase the temperature of one kilogram of the substance by one Kelvin degree.
Stones	Soil particles more than 2 mm in diameter.
Structure	The aggregation of primary soil particles into units separated from each other by surfaces of weakness, 'architecture' of soil - how it is constructed and made up.
Texture	The relative proportions of sand, silt, and clay particles in a mass of soil. Texture can be coarse (sand particles predominate), medium (equal parts of sand, silt and clay), or fine (clay particles predominate). The basic textural classes, in order of increasing proportion of fine particles, are; *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay, and clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine", or "very fine'
Texture triangle	Diagram allotting names to soils with specific portions of sand, silt and clay (http://www.fao.org/3/a-i3794e.pdf), consult Figure:



4.3 Farm and landscape scale

Aspect, exposure	Compass orientation of a slope.
Relief	The elevations or inequalities of a land surface, considered collectively.
Slope	The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, multiplied by 100. Thus, a slope of 20 percent is a drop of 20 m in 100 m of horizontal distance.

5. Weather and climate

Effective rainfall	(1) The rainfall useful for meeting plant water requirements. This does not include water percolating down to aquifers, or surface runoff of water (*cf. definition (2)!*)
	(2) The difference between precipitation and evapotranspiration, i.e. the water percolating to aquifers or surface runoff (*cf. definition (1)!*).
	(3) The amount of rainfall after subtracting the fraction that has been directly evaporated from the canopy surface without reaching the soil surface (as in coniferous forests).
Precipitation	Water reaching the ground from rainfall, snow and hail.

Climatic Zones or Environmental Zones (EnZs, following Metzger et al., 2005)

Nr	Environmental Zone	Main locations and characteristics
1	Alpine North (ALN)	Scandinavian mountains
2	Alpine South (ALS)	The high mountains of central and southern Europe
3	Atlantic North (ATN)	NW Europe; under influence of the Atlantic ocean and the North sea
4	Atlantic Central (ATC)	Western Europe, moderate climate
5	Boreal (BOR)	The lowlands of Scandinavia
6	Continental (CON)	Central Europe; warm summers and cold winters
7	Lusitanean (LUS)	The southern Atlantic area; warm summers and mild winters
8	Mediterranean North (MDN)	Mediterranean north, with Cork Oak, fruit plantations and Olive groves
9	Mediterranean Mountains (MDM)	Mediterranean mountains, influenced by Mediterranean and mountains
10	Mediterranean South (MDS)	Typical Mediterranean climate; mild winter and hot, dry summers
11	Nemoral (NEM)	Southern Scandinavia, Baltic states and Belarus
12	Pannonian (PAN)	Part of Europe with steppes; cold winters and dry hot summers.
13	Anatolian (ANA)	The steppes of Turkey, a Mediterranean environment with steppes

6. Processes

6.1 Soil scale

Absorption	Uptake of matter or energy by a substance.
Adsorption	Process by which atoms, molecules or ions are retained on the surfaces of solids by chemical or physical bonding.
Ammonification	Conversion of organically bound N into ammonium-N by soil biota.
Denitrification	Conversion of nitrate-N into N_2O-N and dinitrogen-N.
Humification	Process whereby the carbon of organic residues is transformed and converted to humic substances through biochemical and abiotic processes.

Immobilisation	Conversion of water-soluble elements into organic compounds by soil biota.
Leaching	Removal of soluble materials from one zone in soil to another via water downward movement in the profile.
Mineralisation	The degradation of organically bound elements (N, P, S) by soil biota into plant-available (inorganic) forms.
Nitrification	Conversion of ammonium-N into nitrite-N and nitrate-N by soil biota.
Oxidation	The addition of oxygen, removal of hydrogen, or the removal of electrons from an element or compound. In the environment, organic matter is oxidized to more stable substances. Oxidation is the opposite of 'reduction'. Oxidation of organic matter is termed 'burning', and that of iron 'rusting'.
Reduction	The addition of hydrogen, removal of oxygen, or the addition of electrons to an element or compound. Under anaerobic conditions (where there is no dissolved oxygen present) such as in 'gley' soils, sulphur compounds are reduced to odour-producing hydrogen sulphide (H_2S) and other compounds. Reduction is the opposite of oxidation.
Seepage, percolation	The movement of water through the soil.
Weathering	The process by which materials in rocks or other deposits are broken down into smaller parts and ultimately their constituents. An example is 'freeze thaw' expansion and cracking. There are physical, chemical and biological weathering processes.

6.2 Plot and farm scale

Buffering of fields	The presence of terraces, treelines, buffer zones, riparian zones, which all contribute to intercepting overland flow.
Drainage (artificial)	Man-made adjustments to a field directed at the removal of excess water by ditches, subsoiling, pipes.
Eutrophication	Process through which a waterbody, such as a lake or a soil solution, becomes enriched with dissolved nutrients. This can be

	natural, but is often due to pollution. Eutrophication may result in algal blooms which finally promote anaerobic conditions which may harm fish life.
Flooding	Inundation of land beside a watercourse, as a result of an excessive water table. This may incur addition of sediment onto the land surface as well as into the water.
Overland flow	Excess water leaving a field horizontally across the soil surface because it cannot infiltrate into the soil, eventually ending up in a ditch or stream (= surface runoff).
Runoff	The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called groundwater runoff or seepage flow from groundwater.

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8. Index of English terms